FRAMEWORK FOR ADAPTIVE FINITE ELEMENT SIMULATIONS: MESH REFINEMENT BASED ON CHARMS

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The present contribution describes an adaptive software framework that is being developed to address formulation of finite element solvers (or related approaches, such as subdivision element method [2], or partition of unity methods) for PDE scientific and engineering models. The basis is the CHARMS (Conforming Hierarchical Adaptive Refinement MethodS) adaptive refinement methodology [1], which can refine/unrefine approximation basis functions constructed on finite element meshes of arbitrary element type and approximation order: quadrilateral, triangular, hexahedral and tetrahedral [3] meshes with Lagrange or Hermite polynomial functions of arbitrary order are supported, and extensions to other types of discretizations have also been explored [2].

At the foundation of CHARMS is the multi-resolution equation, providing CHARMS with generality, robustness, and ease of implementation [1]. Our framework had been so far applied to elliptic (elasticity), parabolic (heat diffusion), and hyperbolic (elastic wave propagation) problems. The framework supports multi-physics algorithms (work on crystal plasticity with dislocation density based hardening model is in progress).

Publications, examples of simulations, and pointers to other information are available on the web [4].

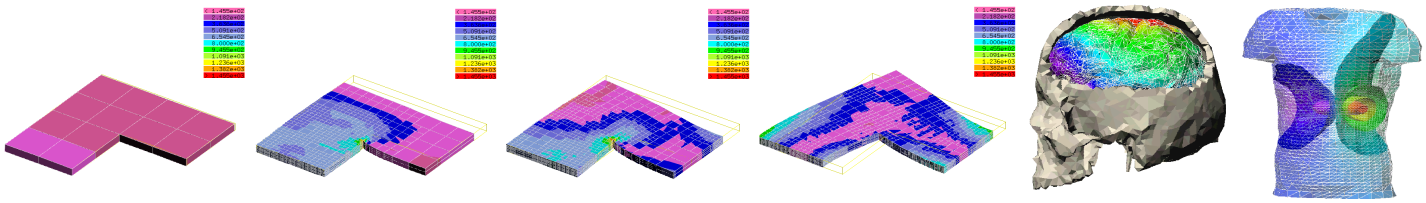

Figure 1: Examples: Adaptive simulation of impact of a thick plate, von Mises stress, displacement magnified; Adaptive simulation of deformation of resected human brain tissue; EEG: Poisson equation solved on a tetrahedral mesh of the human torso.

References

[1] P. Krysl, E. Grinspun, and P. Schröder. Natural hierarchical refinement for finite element methods. *International Journal for Numerical Methods in Engineering*, 2002. to appear.

[2] E. Grinspun, P. Krysl, and P. Schröder. CHARMS: A simple framework for adaptive simulation. *ACM Transactions on Graphics, 21 (3): 281-290 JUL 2002*, 2002.

[3] L. Endres, P. Krysl. Refinement of Finite Element Approximations on Tetrahedral Meshes with Guaranteed Shape Quality *International Journal for Numerical Methods in Engineering*, 2003. submitted.

[4] P. Krysl. `http://hogwarts.ucsd.edu/~pkrysl/charms.html`